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Diagnosis and Management of Esophageal Injuries: A Western Trauma Association Critical Decisions Algorithm

Walter L. Biffl MD,[1] Ernest E. Moore MD,[1] David V. Feliciano MD,[2] Roxie A. Albrecht MD,[3] Martin Croce MD,[4] Riyad Karmy-Jones MD,[5] Nicholas Namias MD,[6] Susan Rowell MD,[7] Martin Schreiber MD,[7] David V. Shatz MD,[8] Karen Brasel MD[7]

[1]Denver Health Medical Center, Denver, CO; [2]Indiana University, Indianapolis, IN; [3]Oklahoma City, OK; [4]Memphis, TN; [5]Vancouver, WA; [6]Miami, FL; [7]Portland, OR; [8]Sacramento, CA

Correspondence: Walter L. Biffl, MD

777 Bannock St., MC 0206

Denver, CO 80204

Phone: 303-602-1861

Fax: 303-436-3123

Email: walter.biffl@dhha.org

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DISCLAIMER: The Western Trauma Association (WTA) develops algorithms to provide guidance and recommendations for particular practice areas, but does not establish the standard of care. The WTA algorithms are based on the evidence available in the literature and the expert opinion of the task force in the recent timeframe of the publication. The WTA considers use of the algorithm to be voluntary. The ultimate determination regarding its application is to be made by the treating physician and health care professionals with full consideration of the individual patient's clinical status as well as available institutional resources; it is not intended to take the place of health care providers' judgment in diagnosing and treating particular patients.

This is a recommended management algorithm from the WTA addressing the diagnostic evaluation and management of esophageal injuries in adult patients. Because there are a paucity of published prospective randomized clinical trials that have generated class I data, the recommendations herein are based primarily on published observational studies and expert opinion of WTA members. The algorithms (**Figures 1 and 2**) and accompanying comments represent a safe and sensible approach that can be followed at most trauma centers. We recognize that there will be patient, personnel, institutional, and situational factors that may warrant or require deviation from the recommended algorithm. We encourage institutions to use this guideline to formulate their own local protocols.

The algorithm contains letters at decision points; the corresponding paragraphs in the text elaborate on the thought process and cite pertinent literature. The annotated algorithm is intended to a) serve as a quick bedside reference for clinicians; b) foster more detailed patient care protocols that will allow for prospective data collection and analysis to identify best practices; and c) generate research projects to answer specific questions concerning decision making in the management of adults with esophageal injuries.

INTRODUCTION

Injuries to the esophagus are uncommon but can be catastrophic, particularly when present in the thoracic esophagus and when diagnosis and treatment are delayed. Penetrating injuries are more common than blunt injuries. In a single urban Level I trauma center with 15% admissions due to penetrating trauma, the incidence of esophageal injury from 2009-2014 was 0.14% (Denver Health Medical Center, unpublished data). The incidence among blunt trauma admissions was

0.06%, compared with 0.6% among penetrating trauma admissions. Of the total, 43% were in the cervical esophagus and 57% in the thoracic esophagus. Iatrogenic and spontaneous (emetogenic) perforations are more common than traumatic esophageal injuries, as reported by Richardson.[1] In his 20-year experience, he operated on 9 traumatic, 18 spontaneous, and 34 iatrogenic perforations. Because of the similarities in diagnosis and management, and the fact that acute care surgeons may be called upon to manage all types of perforations, the algorithms herein (**Figures 1 and 2**) will pertain to all traumatic as well as nontraumatic perforations.

A. A recommended diagnostic approach to the patient with penetrating neck trauma has been published recently by the WTA.[2] As outlined in that algorithm, clinical findings consistent with vascular or aerodigestive injury warrant operative exploration, particularly if the injury is in Zone II of the neck.(**Table 1**) Clinical findings of esophageal injury are unreliable, identifying just 80% of injuries in the cervical esophagus.[3] Thus, nonspecific signs or symptoms, or Zone I injuries, should prompt CT angiography (CTA) of the neck.

B. In general, unstable patients with penetrating thoracic injuries should be taken immediately to the operating room (OR).[4-8] Such patients should be positioned supine to allow access to multiple body cavities (i.e., bilateral pleural cavities and abdomen).[9] If an esophageal injury is identified, appropriate incisions or extensions must be made. A bilateral anterolateral thoracotomy allows access to both pleural cavities. If median sternotomy is initially performed for other indications, a lateral extension may allow access to the proximal (right thoracotomy) or distal (left thoracotomy) esophagus.

C. Penetrating injuries to the chest with potential transmediastinal trajectory were historically investigated with multiple studies including chest radiography, arteriography, bronchoscopy, esophagography, esophagoscopy, and cardiac ultrasonography.[4,6] Many of these studies may be obviated by performing CTA, which has proven to be a safe, efficient, and cost-effective means of determining missile trajectory and targeting specific diagnostic evaluation of organs at risk.[5,7,8,10]

D. The finding of periesophageal air and/or fluid on CT scan are concerning for esophageal injury, and generally mandate further action- especially if in the trajectory of a missile or penetrating object. The exception is the finding of a tiny amount of pneumomediastinum in the absence of fluid or concerning mechanistic, clinical, or other imaging findings. This is a not-infrequent, clinically insignificant finding following blunt trauma and is usually either related to pulmonary injuries or simply an anomaly.[11,12] In such cases it is reasonable to manage patients expectantly, with a brief period of observation and further evaluation in the case of a clinical change.[11-13]

E. Injuries to the hypophanrynx may be safely managed nonoperatively in many cases, as low intraluminal pressure and the overlapping middle and inferior pharyngeal constrictor muscles facilitate a rapid, spontaneous seal of stab and small gunshot wounds.[14,15] Intravenous broad-spectrum antibiotics and restricted oral intake are recommended during healing. In the lower hypopharynx- i.e., below the tips of the arytenoid cartilages- or in the setting of extensive tissue damage, operative intervention is often necessary.[15]

F. CT evidence of cervical esophageal injury should prompt cervical exploration, particularly in the presence of signs or symptoms consistent with injury.[2] This area is easily accessed surgically, with low morbidity, and open exploration allows direct evaluation and repair of the esophagus. This avoids the expense of multiple diagnostic studies and the potential for delay in intervention due to false-negative diagnostic workup. On the other hand, if clinical suspicion is low, abnormal CT findings may be further investigated by esophagoscopy and/or esophagography (see **G**).

G. Evaluation for esophageal injuries involves esophagoscopy and esophagography. In 1987, Weigelt et al[3] reported that in the cervical esophagus, the sensitivity of esophagography was 89%, and thus it was recommended that it be routinely combined with esophagoscopy. Further, in their experience in the early 1980s, flexible esophagoscopy was not sufficiently accurate and missed five (63%) of eight injuries, so they recommended rigid esophagoscopy. More contemporary literature, however, demonstrates that flexible videoendoscopy is very accurate in experienced hands (**Table 2**).[16-19] If endoscopic findings are equivocal, esophagography should follow. The standard technique for contrast esophagography is to first administer water-soluble contrast. It is absorbed rapidly from the mediastinum and thus will not cause mediastinal fibrosis. Because this property also compromises the study's sensitivity, a "negative" water-soluble contrast study should be followed by a confirmatory study using thin barium.[20] This is true even when employing digital fluoroscopy: Buecker and colleagues[21] reported that 22% of injuries were missed with aqueous contrast medium but subsequently diagnosed with barium. As an alternative to fluoroscopic esophagography, helical CT esophagography has been proposed and appears to be very accurate, with the advantages of avoiding the need for additional transportation to the fluoroscopy suite and the active participation of a radiologist, as well as the

potential for misinterpretation of the live images. Further, it allows a contrast study in patients who are unable to actively participate (eg, those who are intubated or mentally altered), as the contrast may be administered via a tube.[22] Given the difficulty in imaging the upper cervical esophagus, and the potential for pulmonary edema if contrast is aspirated, the clinician must weigh the risks versus the benefits of immediate operative cervical exploration.

Conversely, compared with the cervical esophagus, open surgical exploration of the thoracic esophagus is significantly more morbid and thus should not be undertaken indiscriminately. In the past it was suggested that delays to operative repair- even to confirm the diagnosis- resulted in excessive morbidity.[23] However, as reviewed recently by Ivatury and colleagues,[24] the literature suggests that, while the rates of primary repair are lower, delayed diagnosis and treatment of a thoracic esophageal injury do not necessarily lead to adverse outcomes. Thus, an efficient diagnostic evaluation is recommended in the stable patient to rapidly confirm an injury. Potential injury to the thoracic esophagus is similarly pursued by either esophagoscopy or esophagography. In the authors' experience, esophagography is more accurate in the thoracic compared with cervical esophagus, especially if contrast is being administered by tube in the intubated or mentally altered patient.

H. Blunt trauma to the neck may result in significant vascular or aerodigestive injuries, but they are much less common than those following penetrating trauma. As noted above, the incidence of blunt esophageal injuries was one-tenth that of penetrating injuries at an urban Level I trauma center over a recent 5-year period.(DHMC, unpublished data) When a blunt trauma patient with cervical trauma requires immediate surgery, it is usually for airway injury. Signs or symptoms of

vascular or esophageal injury are generally investigated via radiographic or endoscopic studies. The pursuit of nonspecific radiographic findings is outlined in **G**, above.

I. Cervical esophageal trauma is generally managed operatively. A small series from South Africa[25] suggested that nonoperative management could be safe and effective; however, there is a paucity of further data supporting this approach in trauma. The operative morbidity of cervical exploration is low enough that it is difficult to justify any complications related to nonoperative management. The available data pertaining to management of non-traumatic (i.e., iatrogenic or spontaneous) cervical perforations are fairly sparse and not controlled.[26] In the setting of non-traumatic esophageal perforation, there are published series of nonoperative management of small, contained perforations.[27,28] However, a small fraction of the reported cases are in the neck; the large majority are thoracic. In sum, while local expertise might be available to manage cervical esophageal injuries endoscopically or nonoperatively, it is not recommended as the preferred approach at this time unless performed under a controlled institutional protocol.

J. The cervical esophagus is approached via an incision along the medial border of the left sternocleidomastoid muscle; a cervical collar incision can be employed if bilateral cervical exploration is planned. The esophagus should be exposed and circumferentially examined to identify all injuries. Endoscopy is recommended intraoperatively to aid in identifying a perforation that might be obscured by hematoma; to evaluate the opposite side to help identify a through-and-through injury; and to insufflate air following repair to assess for a leak. In addition, endoscopy can identify esophageal pathology that may have contributed to perforation or may be associated with a postoperative leak (e.g., malignancy or stricture).[24,27,29] Methylene blue

administration can also help identify multiple or small perforations such as in the setting of shotgun wounds.

K. The principles of esophageal repair include debridement of contaminated and necrotic material, closure of the defect, and control of esophageal drainage. The classical tenet of performing primary repair when <24 hours from perforation, and avoiding primary repair when >24 hours, has been disproven in clinical studies.[1,24,30,31] Primary repair of cervical esophageal injuries can be performed when there is an ability to get a closure of healthy tissue without tension. The esophagus should be debrided to healthy tissue, and repaired with a single- or double-layer closure using absorbable or nonabsorbable suture (there are no studies comparing the techniques).[1,24] Some recommend nonabsorbable suture with knots on the outside to avoid granuloma formation, but this has not been subjected to rigorous evaluation.[24] One element that is widely recommended is to buttress the repair with vascularized tissue- in the neck, it is simplest to buttress with sternocleidomastoid or strap muscle. This is particularly important when there is concomitant tracheal or carotid artery injury.[24,32,33] The blood supply to the strap muscles originates from the cephalad aspect, so muscles should be divided inferiorly. The sternocleidomastoid muscle has a tripartite blood supply (thyrocervical trunk, superior thyroid artery, occipital artery) and can be detached from bony attachments at either end. It can then be rotated to act as a buttress to an esophageal repair or as an interposition between combined cervical repairs (trachea-esophagus, trachea-carotid artery, esophagus-carotid artery).

L. Following repair, many recommend *nil per os* (NPO) status for several days until there is documentation of healing (e.g., a normal esophagography). This is reasonable in higher-grade

injuries, but in the setting of minor injuries with simple suture repairs, the introduction of liquids can likely occur sooner. A feeding tube will allow provision of enteral nutrition during the period of healing. Drains have been commonly recommended; however, like many other practices, their use has not been scientifically studied. If there is significant contamination a drain is advisable, potentially preventing postoperative abscess formation. In certain additional circumstances such as iatrogenic esophageal injury during cervical spine surgery, placement of a drain is prudent as an abscess could ultimately necessitate hardware removal from the spine.[34]

M. In the case of destructive wounds to the cervical esophagus that cannot be repaired, the esophagus should be extensively mobilized while avoiding injury to the recurrent laryngeal nerves. This will allow for elevation of the injured cervical esophagus over a plastic rod with the perforation acting as a side esophagostomy. If felt to be necessary, the distal lumen of the loop can be temporarily closed with a 3-0 absorbable suture. As edema resolves, the esophagus pulls back to the midline and may allow for a simple delayed transverse closure. Division of the injured cervical esophagus is avoided to prevent the need for a later complex reconstruction. The rare transection of the cervical esophagus, however, may require conversion to an end cervical esophagostomy. Drain placement and enteral feeding access are advised; gastric decompression may be indicated as well.

N. A patient with a very small, contained thoracic perforation and no signs of sepsis may be managed nonoperatively. As noted above (**I**), in the setting of iatrogenic or spontaneous esophageal perforation, published series report good outcomes following nonoperative management of small, contained thoracic esophageal perforations.[27,28] However, these series

have not included traumatic perforations, and it is important to consider that a major distinction between traumatic and non-traumatic perforations is that trauma may disrupt the tissue planes, and thereby the potential containment of the esophageal leak. Thus, nonoperative management of traumatic esophageal perforations should be pursued with caution and ideally under a controlled institutional protocol.

O. A growing body of literature describes the deployment of esophageal stents or the application of clips to seal or close small esophageal perforations in stable patients.[26-28,35,36] The vast majority of patients in these series have sustained iatrogenic or spontaneous perforations, and not external trauma. Dasari and colleagues[26] recently reviewed the existing literature, consisting of 27 case series. The authors conclude that stenting appears to be a safe, effective and acceptable means of controlling esophageal leaks. However, they point out that many issues remain unresolved from this body of literature. There has been no direct comparison with surgical repair or nonoperative management; there is incomplete documentation of time to healing and complications including exacerbation of tears, esophageal perforation, bleeding, and stricture; and the reported mortality rates (13% overall) are of uncertain duration. Local expertise dictates whether esophageal stenting or clipping are options. If these strategies are employed, it is important to debride the perforation site and provide adequate drainage. This may be done thoracoscopically. In addition, provision of enteral nutrition must be achieved via either nasogastric tube or gastrostomy/jejunostomy tubes.

P. Patients with hemodynamic instability or sepsis, or larger or older perforations, should undergo surgical repair. The unstable patient should be positioned supine and undergo

anterolateral thoracotomy, particularly if other injuries are present or suspected. The more stable patient or one in whom the diagnosis is definitive and other injuries have been ruled out, may undergo posterolateral thoracotomy. The proximal esophagus is approached via right thoracotomy incision, and the distal esophagus via a left thoracotomy. As discussed above (**J**), intraoperative endoscopy is recommended to aid in identifying the site(s) of perforation, to assess for a leak following repair, and to identify esophageal pathology that may have contributed to perforation or may be associated with a postoperative leak (e.g., malignancy or stricture).[24,27] Methylene blue may be helpful as well. Debridement of contaminated and necrotic tissue is a cornerstone of management.

Q. Primary repair of esophageal injuries can be performed when there is an ability to get a closure of healthy tissue without tension.[1,13,24,31] The esophagus should be debrided to healthy tissue and repaired as described in **K**.[1,24] In the thoracic esophagus, it is recommended based on expert opinion that the repair should be buttressed with pleura, pericardium, intercostal muscle, diaphragm, or stomach (in the case of distal perforation). Drains have been commonly recommended-however, like many other practices, their use has not been scientifically studied. If there is significant contamination a drain is advisable to potentially prevent abscess formation. Following repair, most recommend avoiding swallowing until there is documentation of healing-generally, by normal esophagography 5 days after repair. A feeding tube will allow provision of enteral nutrition during that period.

R. If primary repair is not possible due to contamination or unstable patient physiology, but there is only a small amount of tissue loss, an effective strategy is to repair the esophagus around a

surgeon-constructed large T-tube.[37,38] This creates a controlled esophageal-cutaneous fistula which may close spontaneously after edema resolves and the T-tube is removed.

S. More extensive tissue loss creates a significant challenge. In this case, it is appropriate to perform esophageal diversion. A side-cervical esophagostomy (as described in **M**) is created through a left cervical incision; the esophagus is debrided and drained; a gastrostomy is created, and a feeding jejunostomy placed.[1,13,24] Reconstruction is planned months later. It should be noted that in the setting of a perforated esophageal malignancy, or in the presence of a severe structure, esophageal resection is an appropriate primary procedure.[1] This would be rarely indicated in a trauma patient.

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TABLE 1. Signs and symptoms suggestive of vascular or aerodigestive injury.

Airway compromise
Significant subcutaneous emphysema or air emanating from neck wound
Hemoptysis
Active bleeding from wound
Expanding or pulsatile hematoma
Hematemesis
Dyspnea
Odynophagia

Table 2. Data from trials on flexible endoscopy for evaluation of esophageal injuries.

First Author	Patients, n	Injuries, n	SENS, %	SPEC, %	PPV, %	NPV, %	Accuracy, %
Flowers[16]	31	4	100	96			97
Srinivisan[17]	55	2	100	92	33	100	
Arantes[18]	163	23	96	100	100	99	99
Ahmed[19]	33	20	100	100	100	100	100

SENS, sensitivity; SPEC, specificity; PPV, positive predictive value (PPV); NPV, negative predictive value